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Heat-charging pipes in dirt
Photo credit: James Williams

July 2025

KEY POINTS FOR DECISION MAKERS

- **Thermal energy storage in dirt uses soil or rock to store energy at low energy capacity costs.** Grid electricity heats water in pipes, which transfer heat to the surrounding dirt. This stored thermal energy can then be used to repower steam generators at decommissioned coal (and other) power plants.

- **In electricity systems reliant on wind, solar, and natural gas generation, thermal storage in dirt could play a key role in addressing seasonal electricity demand challenges**, increasingly so with larger shares of wind and solar generation.

- **Over broad ranges of assumed technology costs, electricity generated from decommissioned turbogenerators repowered by thermal energy storage in dirt could cost-effectively help meet electricity demand peaks currently met using fossil generators.** When first entering a market, rapid discharge of large amounts of energy could present a key revenue opportunity under certain conditions.

Dirt-cheap energy storage - Thermal energy storage in dirt for repowering decommissioned coal plants

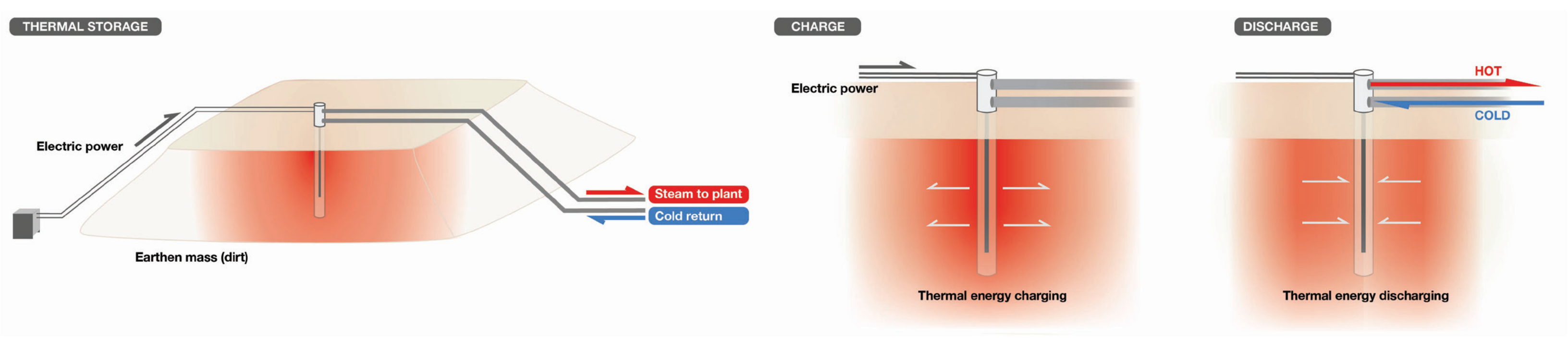
Dirt is an excellent thermal storage medium due to its low thermal conductivity, which limits heat transport to a few meters per year. Thermal energy storage in unconsolidated rocky material (thermal storage in dirt) uses the Earth as a storage medium and is thus characterized by very low energy capacity costs (0.01 $\$/kWh_{th}$ compared to, for example, Li-ion batteries at ~100 $\$/kWh_{e}$).

In this study, cost assumptions are based on a design for a prototype of a dirt-mound thermal energy storage system, which is charged (heated) resistively with pipes embedded in the dirt mound and discharged via the generation of saturated steam (Figure 1). This steam could potentially repower steam turbogenerators of decommissioned coal plants.

Between 2025 and 2030, approximately 50 GW_e of coal plants' capacity will have reached their typical lifespan of about 50 years, and is expected to be retired.

We assess the cost scenarios under which thermal storage in dirt could become cost-effective to repower decommissioned steam turbogenerators. We find that in systems reliant on wind, solar, and natural gas generation, thermal storage in dirt could play a role in meeting seasonal demand peaks at current costs (Figure 2), increasingly so with larger shares of wind and solar generation.

Figure1: Thermal storage in dirt
Sketches by Luke Padgett



Additionally, we evaluated the cost-competitiveness of thermal energy storage when it contributes a large share of electricity to the system compared to when it first enters a market.

When first entering a market, the ability to rapidly discharge large amounts of energy may offer a key revenue opportunity under certain conditions. Across a wide range of assumed technology costs, electricity generated from decommissioned turbogenerators repowered with thermal energy stored in dirt could provide a cost-effective means to meet demand peaks currently served by fossil fuel generators.

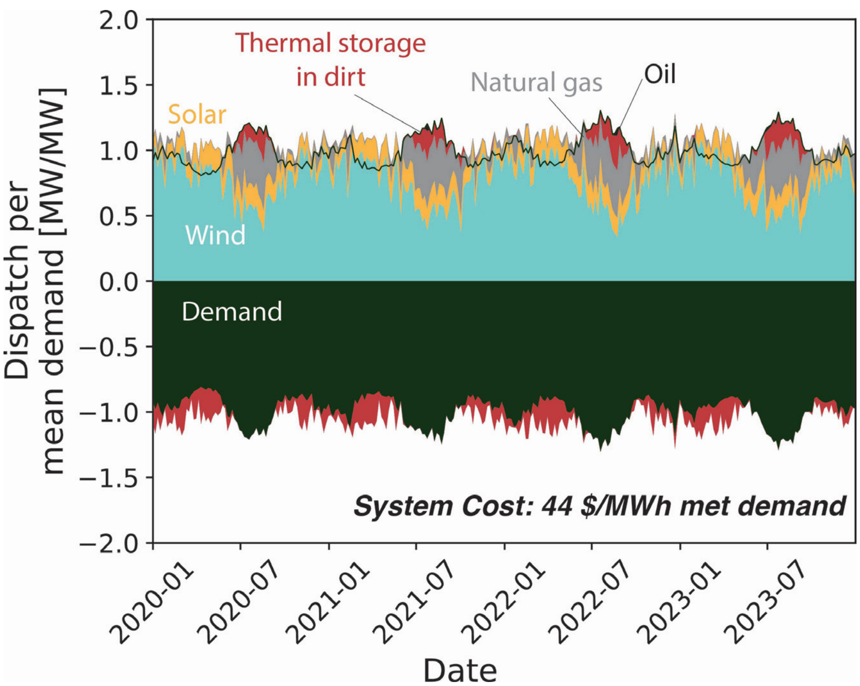


Figure 2: We find that, in the price-maker case with all technologies at current costs, the majority of electricity is supplied by wind generation. Natural gas and thermal energy stored in dirt provide electricity primarily to meet seasonal residual demand challenges posed by wind lulls and concurrent demand peaks.

MORE INFORMATION:

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This brief is based on "Thermal Energy Storage in Dirt for Repowering Decommissioned Coal Plants" published in *Findings* on July 31, 2025 (doi: 10.32866/001c.141340).

This work was supported by a gift from Gates Ventures to Carnegie Science. AW was also supported by Orca Sciences.